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Abstract

This guide, prepared for the Division of Manpower Development and Training, is to assist administrators and teachers in organizing courses and developing course content. The guide contains 14 major units covering 1,764 hours of instruction in the classroom and the laboratory. The course covers 252 days at a rate of 7 hours per day for 5 days a week. Each unit contains: (1) suggested training time, (2) unit objectives, (3) unit outline, (4) suggested activities or shop exercises, and (5) a list of references. Supplementary materials include a suggested list of machines, tools, equipment, supplies, textbooks, films, and a floor plan of the training facility. (GR)

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automotive mechanic entry

a suggested guide for a training course

VTC09590

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OE–87041

AUTOMOTIVE MECHANIC ENTRY

(D.O.T. Occupational Code 620.281
Automobile Mechanic, Entry)

A Suggested Guide for a Training Course

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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OFFICE OF EDUCATION

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Foreword

The Purpose of this guide is to assist administrators and teachers in organizing courses and developing course content. It was prepared for the Division of Manpower Development and Training, under the supervision of its director, Howard A. Matthews. Recognition is given to Maurice W. Roney, Professor of Industrial Education, Oklahoma State University, for supervising the development of content; to L. Carl Love, Oregon State University, for his assistance as consultant during the preparation of this guide; and to Dennis N. Chapman, Head of Automotive Department, Oklahoma State Technical Institute, for gathering the technical content of this guide.

The guide contains 14 major units covering 1,764 hours of instruction in the classroom and the laboratory. The sequence of instructional material and the hours assigned are suggestions; therefore, both time and content may be adjusted to meet local needs.

A suggested list of machines, tools, equipment, supplies, textbooks, films, and a floor plan of the training facility have been included for reference in organizing the course. The assistance of local advisory groups should be sought for guidance in selecting equipment which will best serve local conditions. Modification of the suggested shop layout should follow advisory committee recommendations.

GRANT VENN,
Associate Commissioner for
Adult, Vocational, and Library Programs.

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Background

Purpose of the Guide

This training guide has been prepared to assist in planning and developing a course of training for workers in the automotive field and allied industry who may be concerned with the maintenance and rebuilding of automotive systems. The guide has been organized to be of maximum value to school administration personnel who may not be specialists in the occupation.

No attempt has been made to cover every detail of instruction, but rather to suggest a universal approach in the training of automotive mechanics. The sequence of presentation as well as the final selection of topics for special emphasis should be determined by instructional specialists and will vary, depending upon the needs and background of the trainee group. Supplemental material may be found in the recommended textbooks, references, and films.

Although this training guide has been developed primarily for use by the Manpower Development and Training Program, it includes instructional material that will help the trainees to develop and advance beyond the basic skill requirement for job application. Much of the related material included in the course outline has been added specifically for the purpose of assisting the trainee to progress beyond the entry level classification.

Job Description

The work of the automotive mechanic consists of those jobs which require a knowledge of mechanical, electrical, and hydraulic systems; plus the ability to maintain, repair, and rebuild automotive equipment. In the larger shops, the workers may specialize in certain phases of work. However, many mechanics, especially in organizations with few employees, may be required to be competent enough to do all of the distinctly different types of jobs generally accepted by this type of service industry. If the automotive mechanic has a broad knowledge of a complete mechanism, he can improve the performance of a specific part by virtue of his understanding of the operation of this part as an integral unit of the system.

The automotive mechanic is responsible for mechanical systems such as: electrical, fuel, braking, suspension, power, transmission, and accessory systems. Also, the mechanic is responsible for the roadability of the vehicle and the control of factors such as vibrations, road noises, and rattles.

The automotive mechanic must be able to diagnose mechanical troubles, frequently with only a minimum of symptoms, and correct the cause of these troubles. He performs such activities as disassembling and overhauling engines, transmissions, clutches, rear ends, and other assemblies, replacing worn or broken parts, grinding valves, adjusting brakes, tightening body bolts, and aligning wheels. He uses hoists, wrenches, gauges, drills, grinding wheels, and other general or specialized machines and tools. Since the mechanic's time is usually charged to the customer on an hourly or flat rate basis, it is essential that he eliminate mistakes and the costly delays that come from a trial and error method of troubleshooting.

Generally the work involves contact with grease and dirt; consequently, the worker must learn to tolerate these conditions.

The automotive mechanic with good qualifications can expect job opportunities in almost any locality. There are an estimated 750,000 automotive mechanics employed today making this one of the larger vocations in the technical field. Earnings, which depend upon skill and speed, average from $2.50 to $4.00 per hour. Automotive mechanics are sometimes paid on a flat rate plus a specified percentage of the cost of certain jobs.

According to a recent (1968) survey of job facts, there are 12,000 job openings for automotive mechanics. This does not include mechanic jobs in truck, tractor, aircraft, motorcycle, and allied fields.

The opportunities for automotive mechanics are expected to increase. One reason for this increase is the increase in vehicle registrations. One of the automotive trade journals identified approximately 87 million privately owned vehicles in the United States in 1965. This was reported to be a gain of approximately 4.5 percent over 1964. Another reason for greater opportunities in the field of automotive maintenance and repair is the rise of the national

income which creates a much greater potential market.

It can be concluded that with a shortage of trained mechanics, an increase in the number of vehicles, and the retirement of existing service department personnel, the industry will experience a continuous need for well-trained automotive mechanics.

Training and experience in the automotive industry can also prepare workers for rewarding job opportunities in such fields as service management, sales, merchandising, technical advising, and technical training.

Length of Course and Course Units

The training course covers a period of 252 days and includes a total of 1,764 hours of class instruction and closely supervised shop practice. The training is intended to progress at a rate of 7 hours per day, 5 days a week.

MAJOR DIVISIONS

Unit	*Title*	*Suggested class hours*	*Suggested shop hours*
I.	Introduction	14	7
II.	Basic Electrical Theory	21	50
III.	Automotive Electrical Systems	40	120
IV.	Fuel Systems	21	112
V.	Tune-up	49	170
VI.	Brake Systems	24	100
VII.	Suspensions and Steering	28	135
VIII.	Wheel Balance	6	20
IX.	Transmissions, Standard	9	100
X.	Clutch Systems	7	25
XI.	Differential and Rear Axle	14	100
XII.	Transmissions, Automatic	49	220
XIII.	Engines	52	200
XIV.	Ventilating Systems	21	50
	Subtotal	355	1,409
			355
	Total		1,764

Qualifications of Trainees

Although no reliable method has been found to determine the type of person who can be the most successful in this field, there are some selection factors that may significantly reduce the number of people who will drop out before finishing the course.

The person most likely to succeed in this training program must have both an interest in automotive work and a determination to learn. Manual dexterity and a willingness to do a job that will produce quality results are of great significance if the trainee is to advance to positions with greater responsibility and pay.

A high school diploma is not mandatory, although certain high school courses will help the trainee make more rapid progress during training. Since many of the automotive systems are quite complex, persons applying for this training program should be able to solve basic arithmetic and physics problems. The trainee should receive satisfactory scores in the U.S. Employment Service General Aptitude Test Battery for Automotive Mechanic, B–276.

Teacher Qualifications

The instructor for this program must have experience as an automotive mechanic and, preferably, should have business experience as an operator or supervisor of an automotive repair shop.

If the person selected for this teaching assignment has no teaching experience, he should take fundamental courses in teaching, and lesson planning and presentation.

Suggestions for the Organization of Instruction

The course presented in this training guide is intended to develop a skill level which will qualify individuals for employment. While this is the major objective, the course is also designed to encourage the trainee to learn related material that may help him excel in automotive mechanics.

Shop experience as well as classroom instruction should be carefully chosen to give the trainee as many varied experiences as possible. When a local course is organized, the instructor should evaluate the total experiences listed in this program in view of current occupational requirements. If some special equipment is not available to the instructor, he may plan visits to local related industries in order to provide well-rounded training.

The allocation of hours to each unit of instruction serves to indicate the relative emphasis to be placed on these areas. However, this course is designed to represent a typical situation, and changes in the distribution of time may be necessary to adapt this program to local conditions and the background of the group in training. Furthermore, the ratio of classroom to shop time should be left to the discretion of the instructor.

It should be noted that this training guide was designed for a class of 20 persons, while the optimum trainee-teacher ratio in the shop would be about 10 to 1. A great deal of individual instruction and close supervision is required to teach the skills, especially in the early stages of the course.

Course Units

Unit I

INTRODUCTION

Training Time

Classroom, 14 hours; shop, 7 hours

Objectives

To orient trainees to the nature and scope of the automotive mechanic's work.
To develop skills in the use and maintenance of tools and equipment.

Unit Outline

A. Orientation
   1. Class procedure
   2. History of the automobile
   3. Opportunities in the trade (local)
B. Tools and equipment
   1. Types normally used
   2. Proper use
   3. Maintenance
C. Tool room procedure
D. Parts manual
E. Shop safety practices

Suggested Activities

Demonstration on use of tools of special equipment.
Maintenance of tools and equipment.
Make out requisitions for parts.

References

ABC's of Hand Tools. General Motors Co.
Basic Hand Tools. Government Printing Office.
Chilton's Flat Rate and Parts Manual. Chilton Books.

Unit II

BASIC ELECTRICAL THEORY

Training Time

Classroom, 21 hours; shop, 50 hours

Objectives

To develop an understanding of basic electrical theory and the use of electrical testing equipment.

Unit Outline

A. Electrical terms and symbols
   1. Volts
   2. Ohms
   3. Resistance
   4. Fuse
   5. Ground
   6. Power source
   7. Switch
B. Circuit requirements
C. Conversion factor
D. Magnetism
   1. Theory
   2. Application
E. AC and DC
   1. Theory
   2. Application
F. Use of electrical circuit testing equipment
   1. Ohmmeter
   2. Wattmeter
   3. Battery tester
   4. Battery hydrometer
   5. Battery charger

Suggested Shop Exercises

Problems in solving circuits.
Testing model circuits.
Practice working for schematic and sketches.

Unit III

AUTOMOTIVE ELECTRICAL SYSTEMS

Training Time

Classroom, 40 hours; shop, 120 hours

Objectives

To develop skills in analyzing electrical systems and provide practice in making adjustments and replacement of parts.

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Unit Outline

A. The charging circuit
   1. Battery
   2. Generator
   3. Alternator
   4. Voltage regulator
B. The starting circuit
   1. Battery
   2. Switch (starting)
   3. Starter motor
C. Ignition system
   1. Primary circuit
      a. Battery
      b. Coil (primary winding)
      c. Condenser
      d. Distributor (contact points)
      e. Ground
   2. Secondary circuit
      a. Coil (secondary winding)
      b. Distributor (rotor and cap)
      c. Spark plugs
      d. Ground
D. Lighting and accessory circuits
   1. Safety group
      a. Horns
      b. Lights
      c. Turn signals
      d. Switches and relays
      e. Windshield wipers (electric)
   2. Convenience group
      a. Lights
         (1) Glove compartment
         (2) Trunk
         (3) Map reading
         (4) Courtesy
      b. Radio
      c. Heater
      d. Cigarette lighter

Suggested Shop Exercises

Analyze service efficiency of the principal parts of the electrical system.
Make adjustments to and replacements of components of all circuits.
Troubleshooting procedures.

References

Automotive Electrical Systems. Automotive Electrical Association.
Blanchard and Ritchen. *Auto Engines and Electrical Systems*.

Unit IV

FUEL SYSTEMS

Training Time

Classroom, 21 hours; shop, 112 hours

Objectives

To develop skills in the repair and adjustment of fuel systems.

Unit Outline

A. Operation of component parts
B. Symptoms of inefficient system
C. Servicing procedures
   1. Fuel lines
   2. Fuel pump
   3. Fuel filter
   4. Sediment bowl
   5. Air cleaner
   6. Carburetor

Suggested Shop Exercises

Troubleshoot fuel system.
Test, assemble, clean, and adjust all major components of the fuel system.

References

Automotive Fuel System. Automotive Electrical Association.
Glenn. *Glenn's New Auto Repair Manual*.
Graham. *Audel's New Automobile Guide for Mechanics, Operators, and Servicemen*.
Smith. *Tuning for Speed and Tuning for Economy*.
Sun Tune-up Handbook. Sun Electric Corp.

Unit V

TUNE-UP

Training Time

Classroom, 49 hours; shop, 170 hours

Objectives

To provide practice and develop skills in motor tune-up.

Unit Outline

A. Fundamentals of the internal combustion engine (for tune-up purposes)
   1. Cycle
   2. Compression ratio
   3. Compression pressures
   4. Valves and cam shaft functions
   5. Cooling
B. Review of fuel system principles
   1. Carburetor fundamentals
      a. Air–fuel ratio
      b. Air and fluid pressure vs. vacuum
         (1) Venturi action
         (2) Types of venturi
   2. Carburetor venting
   3. Carburetor circuits
C. Electrical system
   1. Spark plugs
   2. Vacuum advance
   3. Centrifugal advance
   4. Timing
D. Principle equipment required for tune-up.

Suggested Shop Exercises

Visual check of electrical and mechanical systems.
Use of instruments for testing engine compression, electrical components, and the fuel system.

References

Smith. *Tuning for Speed and Tuning for Economy.*
Sun Tune-up Handbook. Sun Electric Corp.

Unit VI

BRAKE SYSTEMS

Training Time

Classroom, 24 hours; shop, 100 hours

Objectives

To develop skills in the repair and adjustment of automotive brakes.

Unit Outline

A. Evolution of brake operating systems
   1. Early types
   2. External contracting mechanical brakes
   3. Internal expanding brakes
      a. Mechanical brakes
      b. Hydraulic brakes
   4. Disc brakes
B. Braking principles
   1. Define braking action
   2. Define friction
   3. Explain stopping distances
C. Components of brake systems
   1. Brake pedal and linkage
   2. Master cylinder
   3. Wheel cylinders
   4. Brake drums
   5. Brake shoes
   6. Brake lining
   7. Backing plate
   8. Brake springs

Suggested Shop Exercises

Troubleshoot brake systems.
Maintenance and repair of brake system components.
Replace brake linings.
Grind brake drums.

Reference

Venk *et al. Automotive Suspensions, Steering, Alignment, and Brakes.*

Unit VII

SUSPENSIONS AND STEERING

Training Time

Classroom, 28 hours; shop, 135 hours

Objectives

To provide training to develop skills in the repair and alignment of automotive suspension and steering systems.

Unit Outline

A. History and evolution of suspension and steering systems
B. Types and function of suspension systems
   1. Front-end suspension
   2. Rear-end suspension
C. Types of steering systems
   1. Mechanical
   2. Power
D. Purpose of wheel alignment
E. Factors governing wheel alignment

F. Maintenance of suspension and steering systems
G. Corrective procedures for suspension and steering system troubles

Suggested Shop Exercises

Analyze and replace defective springs.
Adjust and replace torsion bars and sway eliminators.
Inspect and replace shock absorbers.
Check and align front-end and steering.
Replace mechanical and power steering parts.

References

Graham. *Audel's New Automobile Guide for Mechanics, Operators, and Servicemen.*
Venk *et al. Automotive Suspensions, Steering, Alignment, and Brakes.*

Unit VIII

WHEEL BALANCE

Training Time

Classroom, 6 hours; shop, 20 hours

Objective

To develop skills in the balancing of wheels.

Unit Outline

A. Purpose of wheel balance
B. Methods of wheel balance
   1. Static
   2. Dynamic
C. Balancing equipment
   1. On-auto balancing
   2. Off-auto balancing
D. Symptoms of wheel balance trouble

Suggested Shop Exercises

Diagnose wheel balance requirements by visual inspection and road testing.
Balance wheels using both the on-auto and off-auto balancer.

References

Automobile Trouble Shooter. Motor Book Dept.
Graham. *Audel's New Automobile Guide for Mechanics, Operators, and Servicemen.*

Unit IX

TRANSMISSIONS, STANDARD

Training Time

Classroom, 9 hours; shop, 100 hours

Objectives

To develop skills in the troubleshooting and repair of standard transmissions.

Unit Outline

A. Types of transmissions
   1. Selective sliding spur gears
   2. Constant mesh
   3. Synchromesh
B. Function of transmissions
   1. Torque
   2. Speed
   3. Powerflow
   4. Attachments
C. Construction and nomenclature
   1. Housing
   2. Gears and shafts
   3. Shifting mechanisms
   4. Bearings

Suggested Shop Exercises

Troubleshooting exercises.
Disassemble and reassemble complete transmission unit.

Reference

Venk and Spicer. *Automotive Maintenance and Trouble-shooting.*

Unit X

CLUTCH SYSTEMS

Training Time

Classroom, 7 hours; shop, 25 hours

Objectives

To develop skills in troubleshooting, repair, and adjustment of clutch systems.

Unit Outline

A. Principle and function of the clutch
B. Types of clutches
   1. Helical coil spring
   2. Diaphragm spring
   3. Single coil spring
C. Nomenclature and operation of clutch components
   1. Pressure plate assembly
   2. Fly wheel
   3. Clutch driven disk assembly
D. Diagnosis procedures for
   1. Slips
   2. Grabs
   3. Noises
   4. Drags
E. Clutch maintenance and adjustments

Suggested Shop Exercises

Analyze defective systems.
Remove and replace components.

References

Crouse. *Automotive Mechanics.*
Glenn. *Automechanics.*
Glenn. *Glenn's New Auto Repair Manual.*
Venk and Spicer. *Automotive Maintenance and Troubleshooting.*

Unit XI

DIFFERENTIAL AND REAR AXLE

Training Time

Classroom, 14 hours; shop, 100 hours

Objectives

To develop skills in troubleshooting, replacement of parts, and maintenance of differentials and rear axles.

Unit Outline

A. Description and functions of the differential
B. Types of differentials
   1. Conventional
   2. Limited slip
C. Lubrication and service of a differential
D. Description and function of the rear axle

Suggested Shop Exercises

Troubleshoot differential and rear axle.
Disassemble, assemble, and repair the components of a differential.
Remove and install rear axle.

References

Automobile Trouble Shooter. Motor Book Dept.
Crouse. *Automotive Mechanics.*
Glenn. *Automechanics.*
Graham. *Audel's New Automobile Guide for Mechanics, Operators, and Servicemen.*
Venk and Spicer. *Automotive Maintenance and Troubleshooting.*

Unit XII

TRANSMISSIONS, AUTOMATIC

Training Time

Classroom, 49 hours; shop, 220 hours

Objectives

To provide a basic understanding of automatic transmissions and develop skills in their maintenance and repair.

Unit Outline

A. Function and operating characteristics of an automatic transmission
   1. Planetary gear system
   2. Fluid coupling
   3. Torque converter
   4. Control valves and servo-mechanisms
B. Nomenclature of components and typical repair requirements
C. Testing and inspecting procedures

Suggested Shop Exercises

Troubleshooting procedures.
Maintenance and service procedures.
Adjust, repair, and replace components of an automatic transmission.

References

Crouse. *Automotive Mechanics.*
Glenn. *Automechanics.*
Glenn. *Glenn's New Auto Repair Manual.*

Graham. *Audel's New Automobile Guide for Mechanics, Operators, and Servicemen.*
Venk and Spicer. *Automotive Maintenance and Troubleshooting.*

Unit XIII

ENGINES

Training Time

Classroom, 52 hours; shop, 200 hours

Objectives

To develop skills in troubleshooting, repair, and adjustment of automotive engines.

Unit Outline

A. Principles of engine operation
   1. Water cooled
   2. Air cooled
B. Major components of automobile engines
   1. Pistons
   2. Cylinder block, head
   3. Valves
   4. Crankshaft
   5. Bearings
C. Principle of engine lubricating system
D. Proper inspecting procedures

Suggested Shop Exercises

Troubleshooting to achieve engine efficiency.
Assemble, disassemble, repair, and adjust engine components.

Reference

Blanchard and Ritchen. *Auto Engines and Electrical Systems.*

Unit XIV

VENTILATING SYSTEMS

Training Time

Classroom, 21 hours; shop, 50 hours

Objectives

To develop an understanding of the principles of air conditioning and heating systems and provide experience in testing and servicing these systems.

Unit Outline

A. Theory of refrigeration cycle
B. Types of refrigerants
C. Components of an air conditioning system and their functions
   1. Compressor
   2. Condenser
   3. Receiver dehydrator
   4. Expansion valve
   5. Evaporator
   6. By-pass and suction valves
D. Principle of the heating system
E. Major components of the heating system

Suggested Shop Exercises

Troubleshoot air conditioning and heating systems.
Repair and replace defective components of air conditioning and heating systems.
Charge and/or evacuate refrigerant within an air conditioning system.

References

Glenn. *Glenn's New Auto Repair Manual.*
Graham. *Audel's New Automobile Guide for Mechanics, Operators, and Servicemen.*
Venk and Spicer. *Automotive Maintenance and Troubleshooting.*

Teaching the Course

Planning the Lesson

The best guide or lesson plan is, of course, one that has been prepared by the teacher, based on his experience and manner of teaching. Although teachers differ in their ways of organizing and coordinating important parts of their presentations, they agree that the purpose of a lesson is effective and meaningful classroom instruction.

Written plans may be brief, but before the class starts the good teacher will establish:

- The goals or objectives of the lesson—the kind of learning desired
- The outline and suggested time schedule for the lesson, including:
  - An interest approach—a way to introduce the lesson, and capture the interest of the trainees and direct their attention to the lesson's goals or objectives
  - Activities which will involve the trainees in discovering new facts and principles, solving realistic problems, or practicing skills
  - A way to summarize the lesson—to help trainees arrive at some valid conclusions and/or to evaluate the extent to which lesson goals have been achieved
- The subject matter content—the facts and principles or main ideas to be brought out in the lesson
- The teaching materials and references to be used

Training Facility Considerations

It is the purpose of this training guide to describe typical training facilities that may be adapted to meet local requirements. Also, all buildings and equipment lists should be considered minimum requirements for an optimum program. The shop floor plan, as shown in this guide, represents what might be done with a minimum size physical plant; if existing buildings are utilized, however, the accessibility of vehicle stalls must be considered. The building should be wide enough to allow for a center driveway 25 feet wide. If locating the working stalls on a 45-degree angle is not objectionable, the aisle width could be reduced to 16 feet.

The classroom facilities for this program should be separated from the shop. It is difficult to concentrate in the environment of the working area where many distractions may exist. Also, the classroom should have shelf space for a reference library and a quiet place to read to encourage greater use of reference materials.

The parts and tool room, as shown, can be stocked with a few commonly used parts and specialty tools selected to give trainees experience in making out requisitions. A service counter open to the parts room will facilitate the handling of tools and special equipment.

Items of personal comfort include lighting, heating, cleanliness, and control of contaminated air. Optimum lighting conditions require an illumination of 50 foot-candles 30 inches above floor level. Radiant heating in the floor is recommended for severely cold geographical areas. However, any environmental control system capable of maintaining 68°F (plus or minus 4°F) for the cold season and a summer temperature control which provides good ventilation will suffice. An exhaust system capable of evacuating vehicle exhaust when all of the stalls are filled should be provided by either an in-the-floor or overhead system. Furthermore, a system of floor drains or gutters (not shown) is conducive to good housekeeping.

In maintaining the policy of indicating a minimum facility, no space has been designated for an air compressor or a parts cleaning tank. It would be highly desirable to have room for these two pieces of equipment although it is not mandatory. The parts cleaning tank should have at least a 100-gallon capacity and a circulating pump and filter.

In the lists of equipment, prices have been included to indicate quality requirements. Here, again, considerable flexibility must be recommended. More detailed specifications will be needed should these lists be used for writing purchase orders.

Criteria for Evaluating Trainee Readiness for Employment

The criteria which serve as guides in determining whether the trainee is ready for employment as an automotive mechanic may not be as clearly defined as in some other occupations. However, some under-

standing and insight into how to provide various services are of such importance that every attempt should be made to evaluate trainee progress.

The use of various evaluative devices is necessary for the teacher and the trainee to accumulate objective information about the growth of the trainee. The following personal qualities and competencies are important to develop or strengthen during the training program.

- Courtesy, friendliness, and tact in dealing with supervisors, fellow workers, and the general public
- Acceptable appearance—grooming, cleanliness, and neatness; sensible choice of clothing
- Good personal habits in speech, mannerisms, cleanliness, and method of work
- Acceptable attitudes—calmness in disorganized situations, cooperativeness, willingness to work with others
- Understanding the role of the automotive mechanic
- Knowledge of automotive mechanic work
- Ability to understand and conform to instructions and directions
- Ability to work with minimum immediate supervision
- Ability to keep repair facilities clean and orderly
- Ability to use and maintain hand tools properly and to test equipment used in automotive mechanic work
- Ability to develop and follow a work plan or schedule
- Understanding and observance of basic safety precautions

Textbooks and References

ABC's of Hand Tools. Detroit: General Motors Company, 1968.

Anderson, Edwin P. *Audel's Domestic Compact Auto Repair Manual*. 1st ed. Indianapolis: T. Audel, 1963.

Automobile Trouble Shooter. 5th ed. New York: Motor Book Dept. 1960.

Automotive Electrical Systems. Detroit: Automotive Electrical Association, 1967.

Automotive Fuel System. Detroit: Automotive Electrical Association, 1967.

Basic Hand Tools. NavPers 10085–A. Washington, D.C.: Government Printing Office, 1963.

Blanchard, Harold Frederick and Ritchen, Ralph. *Auto Engines and Electrical Systems*. 3d ed. New York: Motor Book Dept., 1963.

Chilton's Flat Rate and Parts Manual. Philadelphia: Chilton Books, 1965.

Counterman's Handbook. Detroit: Automotive Electrical Association, 1967.

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Films

Title	*Subject Matter*
ABC's OF HAND TOOLS 16 mm., sound, 33 minutes General Motors Corp. Film Library GM Building Detroit, Mich. 48202	Basic mechanics and engines.
CASE OF THE SLIPPERY OIL 16 mm., sound, 40 minutes Perfect Circle Corp. School Department Hagerstown, Ind. 47346	Basic mechanics and engines.
COOLING SYSTEM 16 mm., sound, 9 minutes Union Carbide Corp. 270 Park Avenue New York, N.Y. 10017	Maintenance.
DIESEL STORY, THE 16 mm., sound, 19 minutes Shell Oil Co. Flushing, N.Y. 11355	History and comparison.
FILL 'ER UP 16 mm., sound, 12 minutes DuPont De Nemours and Co. Wilmington, Del. 19898	Basic mechanics and tune-up.
HANDLE WITH CARE 16 mm., sound, 25 minutes General Motors Corp. Film Library GM Building Detroit, Mich. 48202	Basic mechanics.
INTRODUCTION TO THE HEAT ENGINE 16 mm., sound, 23 minutes Shell Oil Co. Flushing, N.Y. 11355	History and engines.
LET 'ER ROLL 16 mm., sound, 50 minutes Timken Roller Bearing Co. 1835 Dueber Avenue S.W. Canton, Ohio 44706	Basic mechanics.
LEVEL AGE 16 mm., sound, 21 minutes Shell Oil Co. Flushing, N.Y. 11355	Transmissions.

Title	*Subject Matter*
LUBRICATION 16 mm., sound, 30 minutes Bureau of Mines Graphic Services 480 Forbes Avenue Pittsburgh, Pa. 15219	Basic mechanics and engines.
ROUGE, THE 16 mm., sound, 20 minutes Ford Motor Co. Ford Film Library Dearborn, Mich. 48121	History.
SECRET DOOR, THE 16 mm., sound, 22 minutes Ford Motor Co. Ford Film Library Dearborn, Mich. 48121	Basic mechanics.
SECURITY CLEARANCE 16 mm., sound-silent, 21 minutes Modern Talking Picture Service 3 East 54th Street New York, N.Y. 10022	Brake training.
SPARK IN TIME ON THE FIRING LINE 16 mm., sound, 22 minutes Champion Spark Plug Co. 900 Upton Avenue Toledo, Ohio 43607	Tune-up.
STORY OF THE MODERN SPARK PLUG 16 mm., sound, 27 minutes Champion Spark Plug Co. 900 Upton Avenue Toledo, Ohio 43607	Tune-up.
WHAT MAKES IT GO 16 mm., sound, 14 minutes Modern Talking Picture Service 3 East 54th Street New York, N.Y. 10022	Basic mechanics.

Appendixes

Appendix A

SUGGESTED LIST OF MACHINES

Quantity	*Description*	*Estimated cost* [1]
1	Aligning station, front end, complete with accessories	$3, 250. 00
1	Aiming machine, head light.[2]	17. 50
1	Lathe, for turning starter and generator armatures.[2]	120. 00
1	Compressor, air, 5 h.p., 26 cu. ft. displacement capacity, opreating pressure—150 psi.	985. 00
1	Arbor Press, hydraulic, 25-ton capacity.[2]	325. 00
2	Chargers, battery, selenium rectifier type, complete with automatic charge control.[2]	390. 00
1	Grinder, brake lining	255. 00
1	Lathe, brake drum, with brake drum micrometer.[2]	875. 00
1	Relining machine, brake, complete with combination reviter and grinder.[2]	200. 00
1	Drill press, chuck capacity ½″.[2]	450. 00
1	Honing machine, electric, complete with attachments for honing up to 2⅝″ I. D. hone.[2]	1, 129. 00
2	Meters, generator and regulator testing.[2]	240. 00
1	Lathe, bench type, 9″ swing, back geared with ½ h.p. motor.[2]	550. 00
1	Distributor tester, portable type complete for static and dynamic tests.[2]	735. 00
1	Tester, motor analyzer, complete with accessories.[2]	1, 360. 00
1	Cleaner and tester, spark plug	67. 00
1	Refacer, valve, complete	537. 00
1	Grinder, valve seat, complete.[2]	247. 00

[1] Costs in appendixes A, B, C, D, and E were estimated during 1966.
[2] Portable machines.

Appendix B

SUGGESTED LIST OF TOOLS

Quantity	*Description*	*Estimated cost* [1]
1	Detector, leak, for testing air conditioning systems	$125.00
1	Hydrometer, battery	2.50
2	Syringes and water containers, battery	3.00
2	Voltmeters, battery, complete with resistance load test	20.00
1	Drill set, twist, 1/8" to 1/2" by 64	38.00
10 doz	Files, assorted	80.00
2	Hydrometers, 1 for storage battery, 1 for radiator coolant	16.00
2	Pullers, bearing and gear, universal	47.00
2 pr	Calipers, one inside, one outside, 6" capacity	10.00
1	Tool kit, carburetor	170.00
1	Tap and die set, complete to cut any size (N.C. or N.F.) from 1/4" to 3/4"	143.00
1	Tool, flaring, 3/16" to 5/8" O.D. tubing	7.50
1	Gauge, brake shoe and drum	20.00
2	Gauges, automotive tire, 5 to 45 lbs	4.50
1	Gauge, screw pitch, 9 to 40 threads per inch, for 60-degree threads	3.15
1	Hammer, sledge	6.50
1	Micrometer, inside, set complete to measure holes from 2" to 8"	27.50
4	Micrometers, outside, sizes 0–1", 1–2", 2–3", 3–4"	80.00
2	Compressors, piston ring, universal type	7.00
4	Cleaners, ring groove	16.00
4	Rules, steel, 6" long with "T" clip	7.00
4	Rules, steel, 12" long	4.00
1	Soldering iron, 300-watt	13.00
1	Soldering gun, 250-watt	12.00
1	Square, combination, 12"	2.50
1 set	Taps and dies, machine screw, from 4–40 N.C. to 1/2–20 N.F	12.00
1 set	Wrenches, adjustable, one each, 4", 6", 10", and 12"	16.00
1 set	Wrenches, spanner, set of 3, capacity 3/4" to 4 3/4"	10.00
2 sets	Wrenches, electrical, set of 9, 13/64" to 5/16"	15.00
1 set	Wrenches, metric	20.00
2	Drills, portable, electric, 1/4" capacity	60.00
1	Drill, portable, electric 1/2" capacity	50.00
3	Lights, timing	120.00
2	Compressors, valve spring	30.00
1	Wrench, torque, 1/2" drive with swivel head	15.00
1	Drag link and shock arm tool	3.50
2	Pliers, brake spring	7.50

See footnote at end of table.

Quantity	*Description*	*Estimated cost* [1]
20	Individual hand tool sets to be checked out to students for entire class session..	$4, 300. 00
	Sixty-one-piece set consisting of:	
	½″ square drive socket wrench set	
	6-piece phillips screw driver set	
	6-piece standard schank screw driver set	
	4 pairs of pliers (5″ ignition, 6″ common, 7″ diagonal side cutting, 6″ needle nose)	
	12-piece punch and chisel set	
	7-piece pin punch set	
	17-piece ¼″ square drive socket set	
	14-piece combination open-end box-end wrench set (⅜″ to 1¼″ openings)	
	putty knife, air blow gun	
	12″ sheet metal snip with 2½″ jaw	
	thickness gauge set	
	3 hammers (1 ball pein, 1 3-lb. sledge, 1 plastic tip)	
	hacksaw frame and 6 blades	
	spark plug gauge (8-wire sizes)	

[1] Costs in appendixes A, B, C, D, and E were estimated during 1966.

Appendix C

SUGGESTED LIST OF EQUIPMENT

Quantity	*Description*	*Estimated cost* [1]
4	Hoses, air, 25′ length, ¼″ I.D	$25.00
7	Benches, work-metal 6′ x 30″	630.00
1	Dispenser, hydraulic brake fluid, with controls for pressurizing system [2]	60.00
1	Charging station, complete with pump for charging air conditioners [2]	198.00
4	Hoses, ⅝″ I.D. x 25′ long, for water	32.00
4	Pans, for draining water and oil	12.00
4	Chucks, air line	10.00
1	Jig, aligning, connecting rod	150.00
2	Carriers, battery	2.50
1	Bonder and remover, brake lining	42.00
2	Cans, gasoline storage	6.00
4	Cans, waste, complete with spring lift cover	28.00
1	Welding unit, oxyacetylene, complete with hand truck, pressure regulators, 25′ of hose, welding torch and 8 tips, cutting attachment, welding goggles, and igniter.[2]	175.00
4	Extinguisher, fire, approved by local code	200.00
2	Cabinets, steel, 36″ x 18″ x 72″	300.00
1	Cabinet, first aid container complete	6.00
1	Can, oil measuring, 2-qt. with spout	5.00
4	Cans, oil, 5-oz. capacity	6.00
8	Clamps, "C," 6″ capacity	52.00
10	Lockers, personnel, steel, double compartment, 6′ high, 18″ deep, 2′ long	400.00
1	Stone, oil	1.00
1	Hoists, chain, 3-ton capacity. complete with overhead monorail system	370.00
1	Cleaner, steam	584.00
12	Creepers, with universal casters	52.00
1	Degreaser, complete with drum, filter, and circulating pump	240.00
4	Jacks, hydraulic, floor	740.00
1	Jack, transmission, mechanical	185.00
1	Ammeter, 30-ampere capacity, fused to protect movement [2]	22.00
12	Voltmeters, 16-volt scale, fused to protect movement [2]	22.00
12	Stands, automobile, 2-ton capacity [2]	180.00
2	Stands, engine rebuilding, supported to swing through 360° [2]	240.00
1	Tester, coil and capacitor [2]	130.00
10	Lights, extension, with rubber handle, light guard, and 50′ cord	40.00
24	Covers, fender, sponge rubber back	120.00
2	Indicators, dial	45.00
1	Gauge, compression	15.00
1	Magnet, permanent, bar type, ¼″ x 1″ x 6″	5.00
1	Scale, brush and point spring tension, 0–48 oz	8.00
1	Scale, steering gear checking, 0–8 lbs	8.00
1	Dispenser, chassis grease [2]	185.00
1	Dispenser, differential grease [2]	75.00

See footnotes at end of table.

Quantity	*Description*	*Estimated cost* [1]
1	Desk, instructor's, 30″ x 60″ top, 5 drawers	$120.00
2	Cabinets, file, 4-drawer, legal size	140.00
1	Chair, office	60.00
1	Table, demonstration 30″ x 62″ top	60.00
4	Ignition sets	20.00
20	Chairs, folding tablet arm	280.00
1	Projector, motion picture, 16 mm., sound	280.00
1	Projector, still, for slides	135.00
1	Projector, overhead	120.00
1	Screen, movie, 6′ x 8′ size	56.00
1	Stand, tripod, for showing charts	27.00
20	Chests, mechanics', 6-drawer, with top opening	700.00
20	Cabinets, roller, with 3 drawers and storage compartment heavy duty casters, cylinder lock.	900.00

[1] Costs in appendixes A, B, C, D, and E were estimated during 1966.

[2] Portable equipment.

Appendix D

SUGGESTED LIST OF EXPENDABLE MATERIALS

Quantity	*Description*	*Estimated cost*
Assortment	Shim stock assortment, .002″ to .015″	$10.00
110 gal	Solvent, cleaning	40.00
30 gal	Oil, lubricating	36.00
10 gal	Grease, chassis	18.00
Assortment	Compound, valve grinding	4.00
2 gal	Fluid, hydraulic brake	45.00
2 lbs	Solder, wire, ⅛″ diameter resin core	2.90
5 lbs	Solder, wire, ⅛″ diameter acid core	2.90
	Allowance for small parts such as nuts, bolts, machine screws, cotter pins, spark plugs, light bulbs, etc.	500.00
	Allowance for periodic overhead charges such as wiping towel service, tanks of oxygen and acetylene, transparencies, film rental, slide film purchases, etc.	400.00

Appendix E

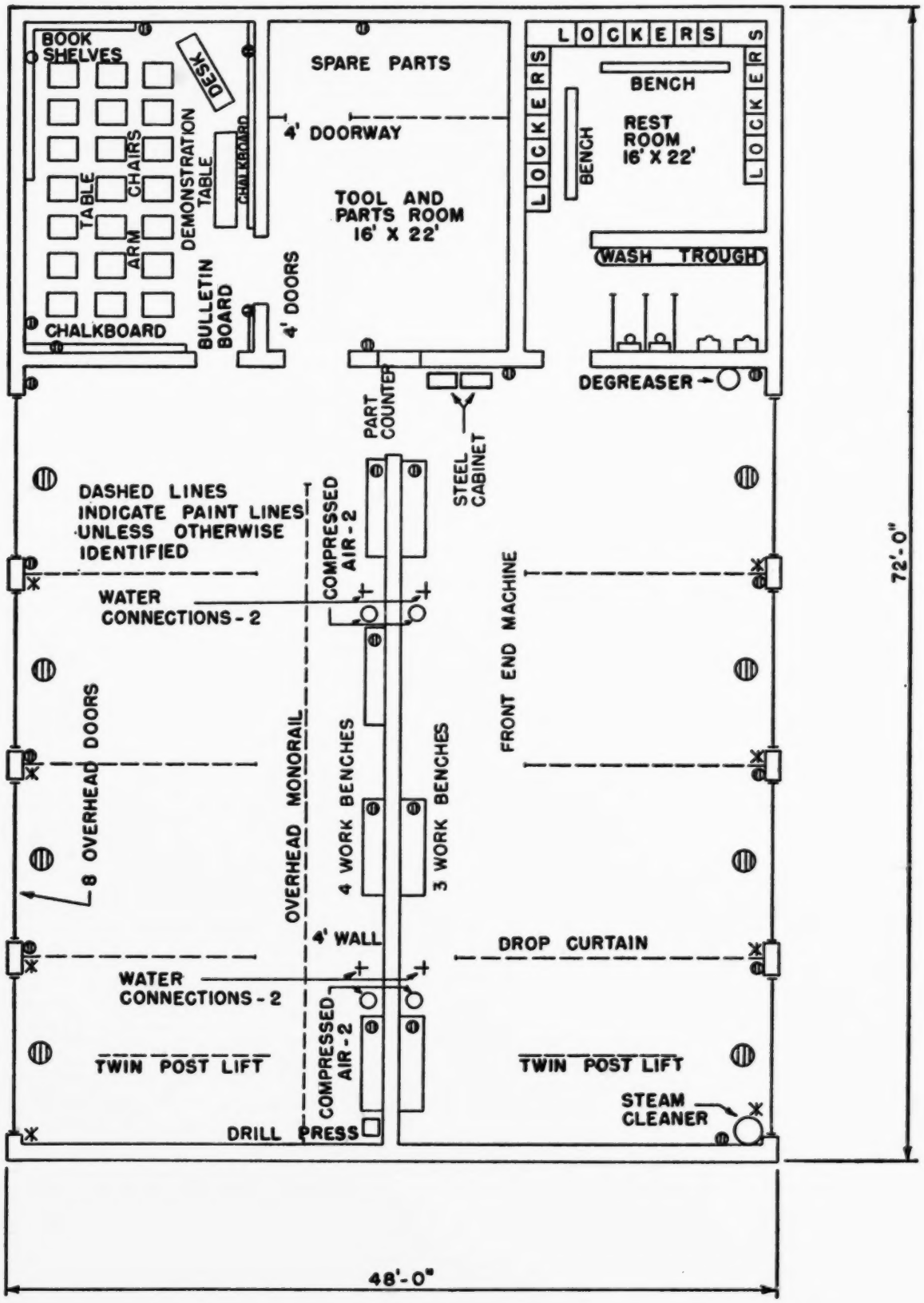
SUGGESTED LIST OF SETS FOR SERVICING

Quantity	*Description*	*Estimated cost* [1]
20	Carburetors (used)	$100.00
20	Brake assemblies, 10 front, 10 rear (used)	50.00
4	Differentials (used)	160.00
6	Distributors (used)	18.00
8	Engines (used)	600.00
4	Pumps, fuel (used)	12.00
4	Generators, direct current, 6- and 12-volt (used)	16.00
4	Alternators, complete with rectifier and regulator (used)	60.00
6	Coils, ignition (used)	18.00
20	Capacitors, distributor (used)	10.00
6	Regulators, voltage (used)	36.00
4	Motors, starting, complete with starting switch	40.00
4	Gear assemblies, steering, 3 manual types and 1 power type complete with pump and connecting lines (used).	100.00
6	Transmissions, 4 standard shift and 2 automatic (used)	300.00

[1] Costs in appendixes A, B, C, D, and E were estimated during 1966.

Appendix F

SUGGESTED TRAINING FACILITY



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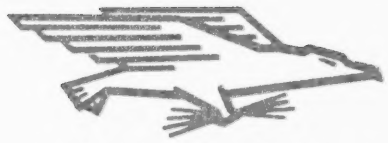

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